PB-242 539

NORTHBORO, HUDSON, MAYNARD, AND BILLERICA IMPOUNDMENTS WORCESTER AND MIDDLESEX COUNTIES, MASSACHUSETTS

Pacific Northwest Environmental Research Laboratory

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16. ABSTRACT

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

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NORTHBORO, HUDSON, MAYNARD, AND BILLERICA IMPOUNDMENTS
WORCESTER AND MIDDLESEX COUNTIES
MASSACHUSETTS
EPA REGION I
WORKING PAPER No. 219

WITH THE COOPERATION OF THE
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AND THE
MASSACHUSETTS NATIONAL GUARD
APRIL, 1975

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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to fresh water lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Massachusetts Division of Water Pollution Control for professional involvement and to the Massachusetts National Guard for conducting the tributary sampling phase of the Survey.

Thomas C. McMahon, Director, John R. Elwood, Supervisory Sanitary Engineer, Eben Chesebrough, Senior Chemist, and Peter A. Tennant, Senior Sanitary Engineer of the Massachusetts Division of Water Pollution Control provided invaluable lake documentation and counsel during the course of the Survey.

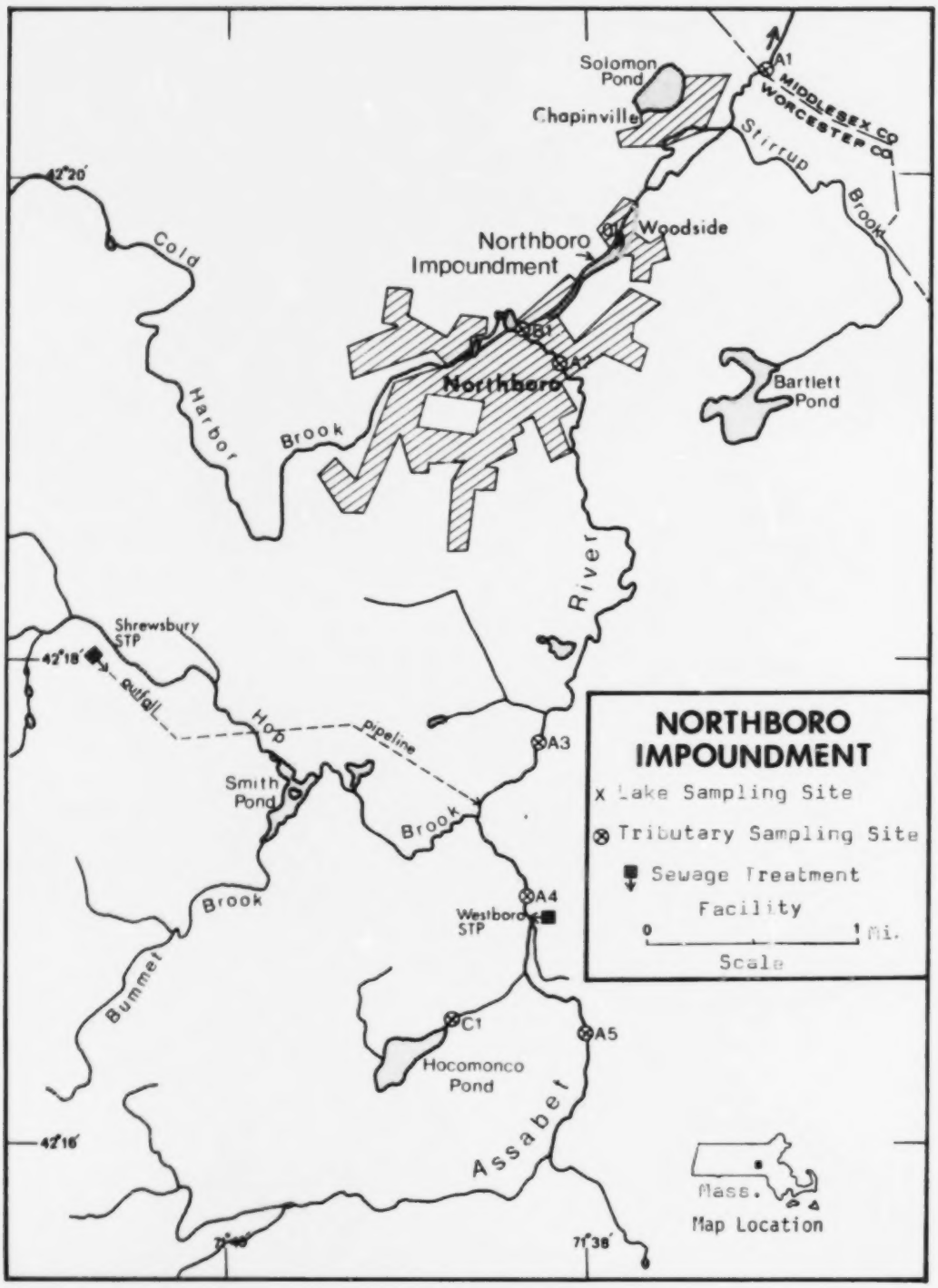
Major General Vahan Vartanian, the Adjutant General of Massachusetts, and Project Officer Major William Flaherty, who directed the volunteer efforts of the Massachusetts National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

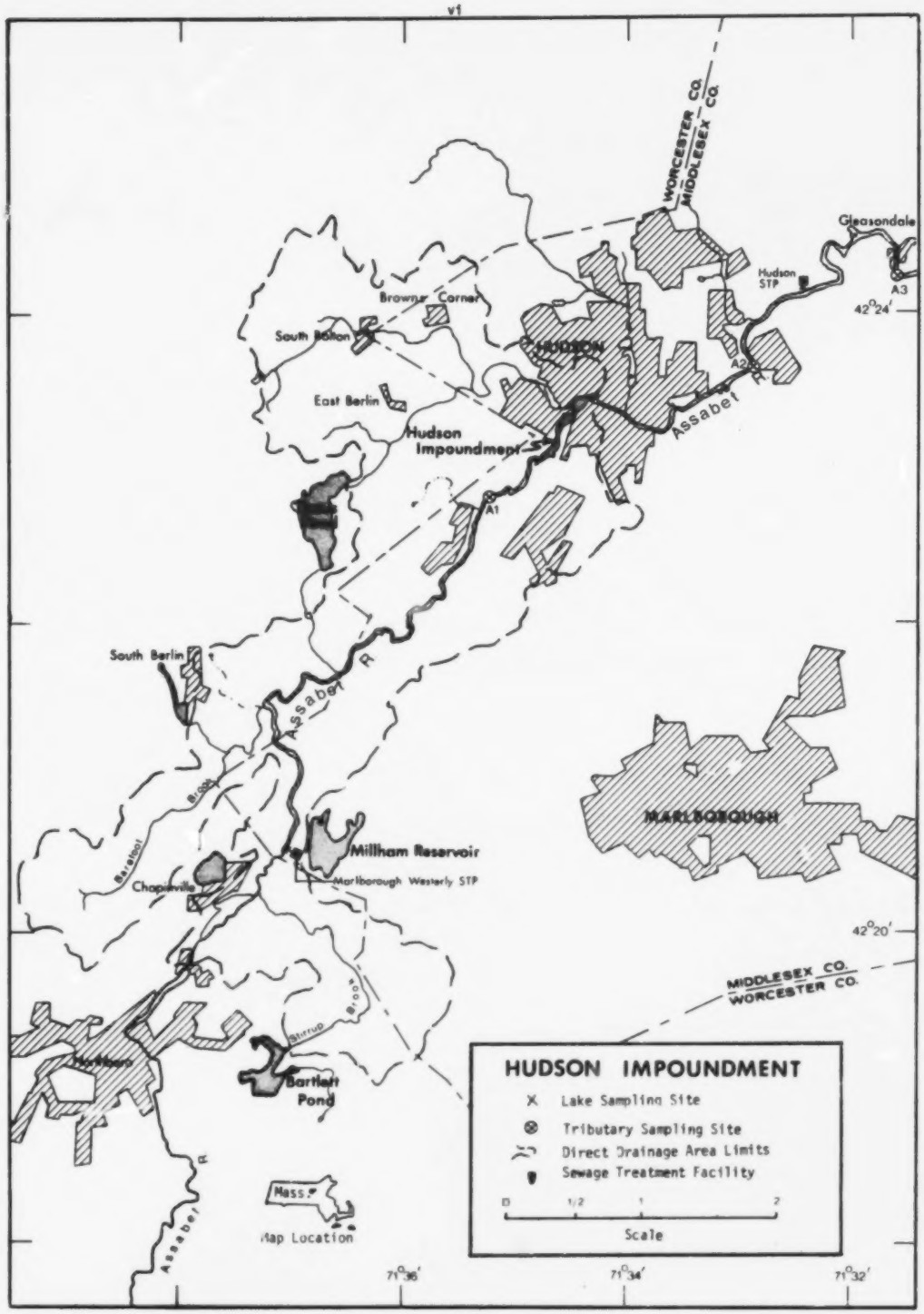
NATIONAL EUTROPHICATION SURVEY

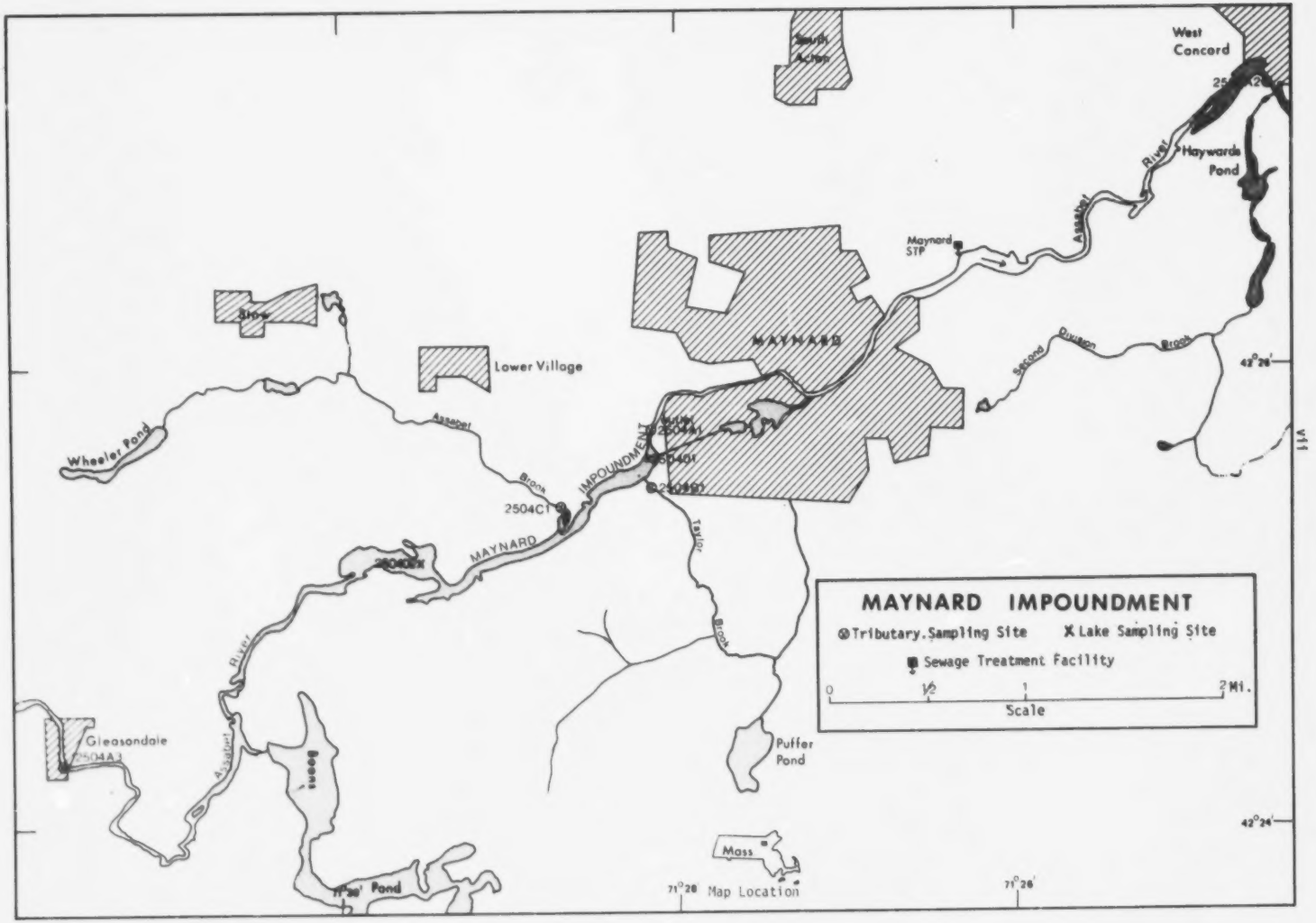
STUDY LAKES

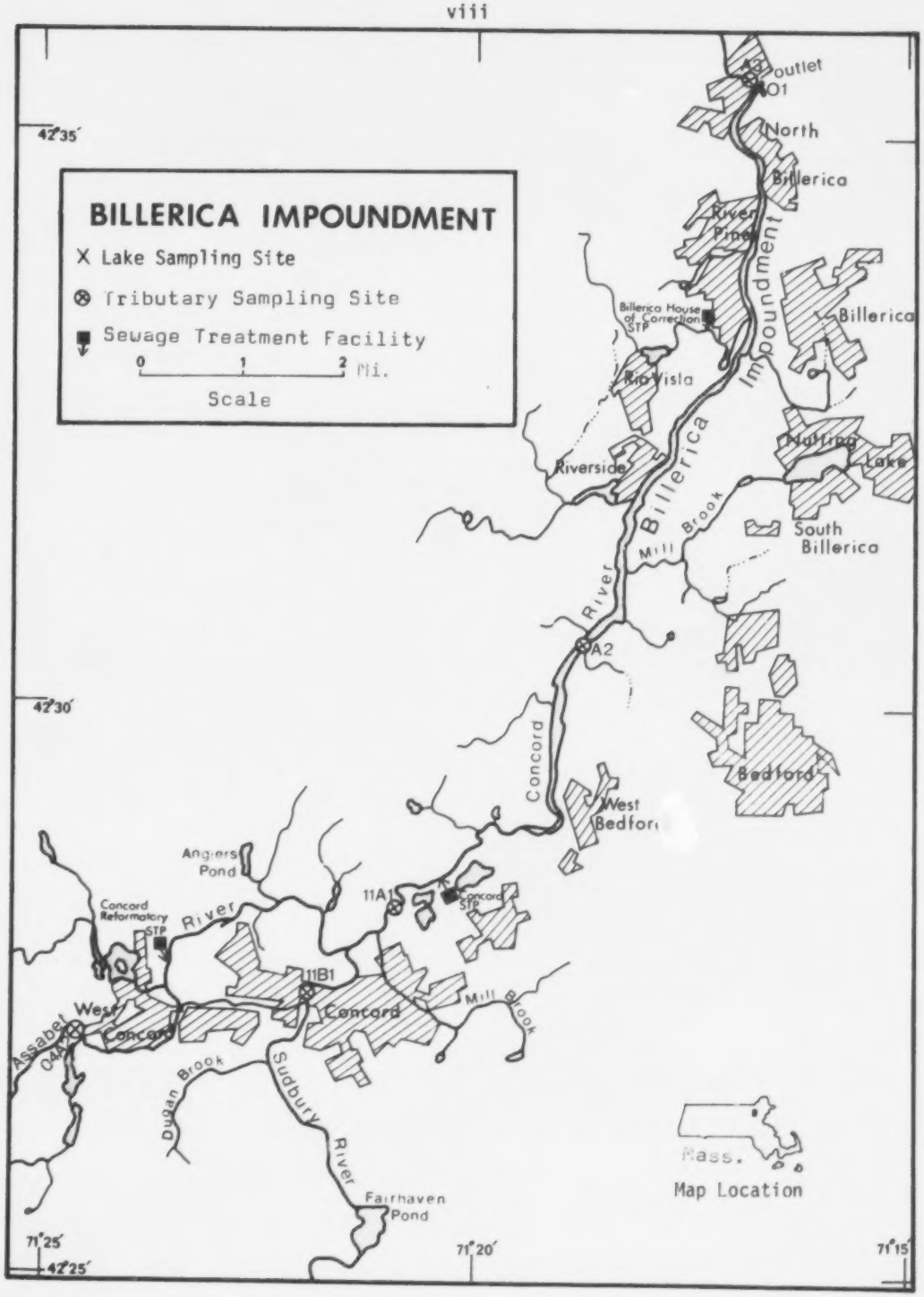
STATE OF MASSACHUSETTS

LAKE NAME	COUNTY
Assabet-Concord River Impoundments	
Northboro	Worcester
Hudson	Middlesex
Maynard	Middlesex
Billerica	Middlesex
Hager Pond	Middlesex
Matfield Impoundment	Plymouth
Rochdale Pond	Worcester
Woods Pond	Berkshire


Solomon Pond
Chapinville
A1
MIDDLESEX CO
WORCESTER CO
Stirrup Brook
42°20'
Cold
Harbor
Brook
Northboro Impoundment
Woodside
B1
A2
Northboro
Bartlett Pond
River
Shrewsbury STP
42°18'
outfall
Hop
Pipeline
A3
Smith Pond
Brook
Brook
A4
Westboro STP
Bummet
C1
A5
Hocomonco Pond
42°16'
Assabet
71°38'
NORTHBORO IMPOUNDMENT
x Lake Sampling Site
⊗ Tributary Sampling Site
Sewage Treatment Facility
0
1 Mi.
Scale
Mass.
Map Location


WORCESTER CO.
MIDDLESEX CO.
Gleasondale
Hudson STP
A3
42°24'
Brown's Corner
South Bolton
HUDSON
A2
East Berlin
Hudson Impoundment
Assabet R.
A1
South Berlin
Assabet R.
MARLBOROUGH
Millham Reservoir
Marlborough Westerly STP
Chapinville
42°20'
MIDDLESEX CO.
WORCESTER CO.
Bartlett Pond
Mass.
Map Location
Assabet R.
71°36'
71°34'
71°32'
HUDSON IMPOUNDMENT
Lake Sampling Site
Tributary Sampling Site
Direct Drainage Area Limits
Sewage Treatment Facility
0
1/2
1
2
Scale


West Concord
Haywards Pond
Assabet River
Maynard STP
MAYNARD
Second Division Brook
Lower Village
Wheeler Pond
Assabet Brook
IMPOUNDMENT
2504C1
MAYNARD
Taylor Brook
Puffer Pond
Gleasondale
2504A1
Assabet River
Boons
Pond
Mass
71°28' Map Location
42°28'
42°24'
MAYNARD IMPOUNDMENT
⊗Tributary Sampling Site
X Lake Sampling Site
Sewage Treatment Facility
0
½
1
2 Mi.
Scale


BILLERICA IMPOUNDMENT
X Lake Sampling Site
Tributary Sampling Site
Sewage Treatment Facility
0 1 2 Mi.
Scale
42°35'
42°30'
42°25'
71°25'
71°20'
71°15'
Outlet
01
North
Billerica
River
Pine
Billerica
Impoundment
Billerica House of Correction STP
Billerica
Rio Vista
Riverside
Billerica
Mill Brook
Nutting
Lake
South
Billerica
River
A2
Concord
West
Bedford
Bedford
Angiers
Pond
11A1
Concord
STP
Concord
Reformatory
STP
River
11B1
Concord
Mill Brook
Assabet
River
West
Concord
04
Dugan Brook
Sudbury
River
Fairhaven
Pond
Mass.
Map Location

NORTHBORO, HUDSON, MAYNARD, and BILLERICA IMPOUNDMENTS

STORET NOS. 2512, 2513, 2504, and 2511

I. CONCLUSIONS

A. Trophic Condition:

The impoundments of the Assabet-Concord River system were quite eutrophic having excessive nutrient levels, high chlorophyll *a* values, and heavy growths of aquatic macrophytes. Phytoplankton genera identified generally were pollution-tolerant forms. Dissolved oxygen concentrations were depressed in the three Assabet River impoundments. The algal assay control yields in samples from the Maynard and Hudson impoundments were extremely high; respectively, three and five times the high yield obtained with the Billerica sample (nutrient levels measured indicate that Northboro Impoundment also had a high primary productivity).

B. Rate-Limiting Nutrient:

Nitrogen was the limiting nutrient in the three impoundments of the Assabet River and also in Billerica Impoundment (Concord River) during the autumn sampling, 1972. The impoundment data indicate nitrogen limitation in all of the impoundments at the other sampling times as well.

C. Nutrient Controllability:

1. Point sources--During the sampling year, the total phosphorus loading rates of all of the impoundments were far higher than the rates proposed by Vollenweider (in press) as "dangerous"; i.e., eutrophic rates (see page 33).

However, Vollenweider's model probably is not applicable to water bodies with short hydraulic retention times. The mean hydraulic retention times of the impoundments are very short, ranging from four hours (Billerica) to 23 hours (Maynard), and it is unlikely that the model applies. Nonetheless, the existing trophic condition of the impoundments is evidence of excessive nutrient loads.

In the following table are shown the existing phosphorus loading rates, the portion of the phosphorus loads attributed to point sources, the loading rates that would result with 100% phosphorus control at the point sources, and how the new loading rates would compare to the eutrophic rate:

Impoundment	Existing rate ($g/m^2/yr$)	% point-source load	Rate w/ 100% control ($g/m^2/yr$)	Exceeds eutrophic rate by factor of -
Northboro	402	82.5	70	14 X
Hudson	249	83.3	42	8 X
Maynard	99	91.9	8	2 X
Billerica	716	60.5	283	23 X

While point-source phosphorus control at Shrewsbury and Westboro would not be expected to result in a significant improvement in the trophic condition of Northboro Impoundment, it is likely that a high degree of control at these sources and all of the downstream point sources would result in appreciable improvement in the trophic condition of Hudson and Maynard impoundments and probably Billerica Impoundment as well, providing the Sudbury River phosphorus load to the latter can be similarly reduced (note that if the estimated Sudbury River phosphorus load is subtracted, point-source loads constitute 87.8% of the total phosphorus load to Billerica Impoundment).

It is noted that apparent loss of nitrogen occurred in every one of the impoundments during the sampling year. Such apparent loss is not uncommon in water bodies with very short hydraulic retention times; but, in these waters, the loss may have resulted from resolubilization of nitrogen from bottom sediments as suggested by Blanc and O'Shaughnessy (1974).

2. Non-point sources (see page 32)--The phosphorus export rate of the Assabet River above Northboro Impoundment was unaccountably high during the sampling year. While the export rate shown is based on the phosphorus load measured at inlet

station A-2 (see map, page v) minus the upstream point-source loads, almost exactly the same export rate results when the mean phosphorus concentrations at station A-5 (13 samples = 0.134 mg/l) and the mean flow at station A-2 are used to calculate the non-point load.

The export rates of the Concord River at station A-2 (see map, page viii) and Taylor Brook, a tributary of Maynard Impoundment (see map, page vii) also markedly exceeded the export rates of Cold Harbor and Assabet brooks (mean = 92 $lbs/mi^2/yr$). While an unknown portion of the Concord River phosphorus export can be attributed to the phosphorus contribution of the Sudbury River, the high Taylor Brook export rate may be due to urban drainage in the Maynard vicinity.

II. INTRODUCTION

Several small impoundments of the Assabet-Concord River system were sampled during 1972. The impoundments are located at Northboro, Hudson, and Maynard, on the Assabet River, and at Billerica on the Concord River. The effluents of nine municipal or institutional wastewater treatment plants impact the river system from the headwaters of the Assabet River near Grafton to Billerica, below Concord, a reach of approximately 40 miles. Maynard Impoundment is located 9.0 to 11.0 miles; the Hudson Impoundment, 18.2 to 19.6 miles; and the Northboro Impoundment, 25.4 to 25.7 miles upstream from the confluence of the Assabet River with the Sudbury River forming the Concord River.

III. LAKE AND DRAINAGE BASIN CHARACTERISTICS
(See Appendix A for flow data)

A. Northboro Impoundment -

1. Lake Morphometry:

   a. Surface area: 15 acres.

   b. Mean depth: 4 feet.

   c. Maximum depth: 5 feet.

   d. Volume: 60 acre-feet.

   e. Mean hydraulic retention times: 13 hours.

2. Tributary and Outlet

   a. Tributaries -

Name	Drainage area*	Mean flow*
Assabet River	20.3 mi^2	30.9 cfs
Cold Harbor Brook	9.7 mi^2	14.8 cfs
Minor tributaries & immediate drainage -	5.4 mi^2	8.2 cfs
Totals	35.4 mi^2	53.9 cfs

   b. Outlet -

Assabet River	35.4 mi^2	53.9 cfs

3. Precipitation**:

   a. Year of sampling: 71.7 inches.

   b. Mean annual: 45.4 inches.

---

* Drainage areas are accurate within ±1%; gaged mean daily, monthly, and normalized monthly flows are accurate within ±15%; and ungaged mean daily, monthly, and normalized flows are accurate within ±20%.

** See Working Paper No. 1, "Survey Methods, 1972".

B. Hudson Impoundment -

1. Lake Morphometry:

a. Surface area: 30 acres.

b. Mean depth: 4 feet.

c. Maximum depth: 6 feet.

d. Volume: 120 acre-feet.

e. Mean hydraulic retention time: 13 hours.

2. Tributary and Outlet:

a. Tributaries -

Name	Drainage area	Mean flow
Assabet River	60.6 mi^2	92.3 cfs
Minor tributaries & immediate drainage -	12.1 mi^2	18.4 cfs
Totals	72.7 mi^2	110.7 cfs

b. Outlet -

Assabet River	72.7 mi^2	110.7 cfs

C. Maynard Impoundment -

1. Lake Morphometry:

   a. Surface area: 80 acres.

   b. Mean depth: 4 feet

   c. Maximum depth: 5 feet.

   d. Volume: 320 acre-feet.

   e. Mean hydraulic retention time: 23 hours.

2. Tributary and Outlet:

   a. Tributaries -

Name	Drainage area	Mean flow
Assabet River	77.1 mi^2	117.3 cfs
Assabet Brook	19.9 mi^2	30.3 cfs
Taylor Brook	4.6 mi^2	7.0 cfs
Minor tributaries & immediate drainage -	11.4 mi^2	17.3 cfs
Totals	113.0 mi^2	171.9 cfs

   b. Outlet -

Assabet River	113.0 mi^2	171.9 cfs

D. Billerica Impoundment -

1. Lake Morphometry:

a. Surface area: 25 acres.

b. Mean depth: 7 feet.

c. Maximum depth: 10 feet.

d. Volume: 175 acre-feet.

e. Mean hydraulic retention time: 4 hours.

2. Tributary and Outlet:

a. Tributaries -

Name	Drainage area	Mean flow
Concord River	250.0 mi^2	504.3 cfs
Minor tributaries & immediate drainage -	26.0 mi^2	37.4 cfs
Totals	276.0 mi^2	541.7 cfs

b. Outlet -

Concord River	276.0 mi^2	541.7 cfs

IV. LAKE WATER QUALITY SUMMARY

The Assabet-Concord River Impoundments were sampled three times during the open-water season of 1972 by means of a pontoon-equipped Huey helicopter, except for Northboro which was only sampled once. Near-surface samples were collected for physical, chemical, and biological parameters in the Assabet impoundments, and additional depths were sampled in Billerica Impoundment where greater depth permitted (see maps, pages v, vi, vii, and viii). During the last visit, a single five-gallon sample was collected for algal assays (except Northboro).

The results obtained are presented in full in Appendix B, and the data for the fall sampling period are summarized below (the Northboro data are for the late spring sampling period). Note, however, the Secchi disc summaries are based on all values.

For differences in the various parameters at the other sampling times, refer to Appendix B.

A. Physical and chemical characteristics:

1. Northboro Impoundment -

Spring Values

(06/03/72)

Parameter	Single Sub-Surface Sample
Temperature (Cent.)	16.4
Dissolved oxygen (mg/l)	6.3
Conductivity (μmhos)	20
pH (units)	6.5
Alkalinity (mg/l)	<10
Total P (mg/l)	0.275
Dissolved P (mg/l)	0.212
NO_2 + NO_3 (mg/l)	0.350
Ammonia (mg/l)	0.250

All Values

Secchi disc (inches)	42

2. Hudson Impoundment -

Fall Values

(10/06/72)

Parameter	Minimum	Mean	Median	Maximum
Temperature	14.9	14.9	14.9	14.9
Dissolved oxygen	7.6	7.6	7.6	7.6
Conductivity	250	253	253	255
pH	6.4	6.5	6.5	6.5
Alkalinity	18	19	19	20
Total P	1.170	1.200	1.200	1.230
Dissolved P	1.160	1.195	1.195	1.230
NO_2 + NO_3	1.760	1.810	1.810	1.860
Ammonia	0.080	0.085	0.085	0.090

All Values

Secchi disc	42	53	58	60

3. Maynard Impoundment -

Fall Values

(10/06/72)

Parameter	Minimum	Mean	Median	Maximum
Temperature	14.6	14.7	14.7	14.8
Dissolved oxygen	6.2	6.2	6.2	6.2
Conductivity	200	221	223	240
pH	6.4	6.4	6.4	6.4
Alkalinity	12	21	23	25
Total P	0.417	0.585	0.552	0.820
Dissolved P	0.356	0.481	0.488	0.590
$NO_2 + NO_3$	0.420	0.980	1.100	1.300
Ammonia	0.100	0.125	0.125	0.150
	All Values			
Secchi disc	36	52	58	72

4. Billerica Impoundment -

Fall Values

(10/06/72)

Parameter	Minimum	Mean	Median	Maximum
Temperature	16.5	16.7	16.7	16.9
Dissolved oxygen	9.0	9.8	9.8	10.6
Conductivity	210	213	215	215
pH	7.0	7.5	7.3	8.2
Alkalinity	23	25	23	28
Total P	0.151	0.155	0.155	0.158
Dissolved P	0.063	0.071	0.071	0.078
$NO_2 + NO_3$	0.290	0.313	0.320	0.330
Ammonia	0.070	0.080	0.070	0.100
	All Values			
Secchi disc	32	40	40	48

B. Biological characteristics:

1. Northboro Impoundment -

a. Phytoplankton -

Sampling Date	Dominant Genera	Number per ml
06/03/72	1. Cyclotella	9,699
	2. Fragilaria	4,436
	3. Melosira	3,684
	4. Navicula	1,654
	5. Cocconeis	1,654
	Other genera	3,911
	Total	25,038

b. Chlorophyll a -
(Because of instrumentation problems during the 1972 sampling, chlorophyll a values may be in error by plus or minus 20 percent.)

Not done at Northboro Impoundment

2. Hudson Impoundment -

a. Phytoplankton* -

Sampling Date	Dominant Genera	Number per ml
08/04/72	1. Cyclotella	38
	2. Synedra	33
	3. Navicula	20
	4. Scenedesmus	18
	5. Cocconeis	16
	Other genera	81
	Total	206
10/06/72	1. Flagellates	294
	2. Microcystis	279
	3. Cryptomonas	136
	4. Anabaena	136
	5. Fragilaria	83
	Other genera	617
	Total	1,545

b. Chlorophyll a -

Sampling Date	Station Number	Chlorophyll a (µg/l)
06/02/72	01	2.5
08/04/72	01	1.3
10/06/72	01	2.9

* The June sample was lost in shipment.

3. Maynard Impoundment -

a. Phytoplankton* -

Sampling Date	Dominant Genera	Number per ml
08/04/72	1. Fragilaria	7,477
	2. Cyclotella	2,252
	3. Cocconeis	1,441
	4. Navicula	1,441
	5. Melosira	1,171
	Other genera	5,317
	Total	19,099
10/06/72	1. Flagellates	844
	2. Cryptomonas	136
	3. Synedra	106
	4. Cyclotella	90
	5. Navicula	90
	Other genera	445
	Total	1,711

b. Chlorophyll a -

Sampling Date	Station Number	Chlorophyll a (µg/l)
06/02/72	01	2.2
08/04/72	01	41.5
10/06/72	01	7.1
	02	5.8

* The June sample was lost in shipment.

4. Billerica Impoundment -

a. Phytoplankton -

Sampling Date	Dominant Genera	Number per ml
06/08/72	1. Cryptomonas	162
	2. Microcystis	141
	3. Synedra	112
	4. Melosira	76
	5. Dinobryon	50
	Other genera	218
	Total	759
08/04/72	1. Chroococcus	1,285
	2. Dinobryon	321
	3. Melosira	281
	4. Schroederia	281
	5. Scenedesmus	251
	Other genera	774
	Total	3,193
10/06/72	1. Stichococcus	32,406
	2. Flagellates	451
	3. Scenedesmus	451
	4. Fragilaria	301
	5. Melosira	301
	Other genera	1,654
	Total	35,564

b. Chlorophyll a -

Sampling Date	Station Number	Chlorophyll a (µg/l)
06/08/72	01	0.9
08/04/72	01	17.5
10/06/72	01	18.3

C. Limiting Nutrient Study:

1. Northboro Impoundment -

Northboro Impoundment was sampled once in June, 1972, and no assay sample was collected. However, the sampling data indicate nitrogen limitation in June (the N/P ratio was 2/1, and nitrogen limitation would be expected). Also, the levels of phosphorus and nitrogen measured indicate a high level of potential primary productivity.

2. Hudson Impoundment -

a. Autoclaved, filtered, and nutrient-spiked -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	0.960	1.940	69.4
0.006 P	0.966	1.940	69.7
0.012 P	0.972	1.940	70.8
0.024 P	0.984	1.940	68.1
0.060 P	1.020	1.940	67.4
0.060 P + 10.0 N	1.020	11.940	267.6
10.0 N	0.960	11.940	254.4

b. Discussion -

The control yield of the assay alga, Selenastrum capricornutum, indicates that the potential primary productivity of Hudson Impoundment was very high at the time the sample was taken (10/06/72). Also, the lack of yield response to increased levels of ortho-phosphorus, and the marked response when only nitrogen was added, indicate nitrogen limitation at that time.

The sampling data indicate nitrogen limitation at the other sampling times as well; the N/P ratio was 3/1 in June and in August.

3. Maynard Impoundment -

a. Autoclaved, filtered, and nutrient-spiked -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	0.470	1.147	41.6
0.006 P	0.476	1.147	43.2
0.012 P	0.482	1.147	43.2
0.024 P	0.494	1.147	41.6
0.060 P	0.530	1.147	42.4
0.060 P + 10.0 N	0.530	11.147	317.0
10.0 N	0.470	11.147	275.5

b. Discussion -

The control yield indicates that the potential primary productivity of Maynard Impoundment was very high at the time the sample was collected (10/06/72). Also, the lack of yield response to increased levels of orthophosphorus, and the marked response when only nitrogen was added, indicate nitrogen limitation at that time.

The sampling data indicate nitrogen limitation at the other sampling times as well; the N/P ratios were 2/1 and 8/1 in June and August, respectively.

4. Billerica Impoundment -

a. Autoclaved, filtered, and nutrient-spiked -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	0.120	0.520	13.1
0.006 P	0.126	0.520	14.3
0.012 P	0.132	0.520	14.1
0.024 P	0.144	0.520	14.0
0.060 P	0.180	0.520	15.1
0.060 P + 10.0 N	0.18C	10.520	79.1
10.0 N	0.120	10.520	50.3

b. Discussion -

The control yield indicates the potential primary productivity of Billerica Impoundment was quite high at the time the sample was taken (10/06/72). Also, the lack of yield response to increased levels of orthophosphorus, and the marked response when only nitrogen was added, indicate nitrogen limitation at that time.

The sampling data indicate nitrogen limitation at the other sampling times as well; the N/P ratios were 3/1 and 2/1 in June and August, respectively.

V. NUTRIENT LOADINGS
(See Appendix C for data)

For the determination of nutrient loadings, the Massachusetts National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the maps (pages v, vi, vii, and viii), except for the high runoff months of March and April when two samples were collected at many of the stations. Sampling was begun in September, 1972, and was completed in August, 1973.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the New England District Office of the U.S. Geological Survey for the tributary sites nearest the lake.

In this report, nutrient loads for sampled tributaries were determined by using a modification of a U.S. Geological Survey computer program for calculating stream loadings*.

Nutrient loadings for unsampled "minor tributaries and immediate drainage" of Northboro and Hudson impoundments ("ZZ" of U.S.G.S.) were estimated using the nutrient loads, in lbs/mi^2/year, in Cold Harbor Brook at station 12B-1 and multiplying the means by the ZZ area in mi^2. The ZZ loads of Maynard and Billerica impoundments were similarly estimated using the nutrient loads in Assabet Brook at station 04C-1.

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* See Working Paper No. 1.

The non-point nutrient loads in the Assabet River at Northboro were determined by using the inlet loads at station 12A-2 minus the upstream point-source loads; the Assabet River non-point loads at Hudson were determined by using the inlet loads at station 13A-1 minus all upstream point-source loads; the Assabet non-point loads at Maynard were determined by using the outlet loads of Hudson Impoundment at station 13A-2 minus all upstream point-source loads (the Maynard inlet station, 04A-3, was sampled only four times, and loads derived from the limited data were obviously too low).

The non-point nutrient loads in the Concord River at Billerica Impoundment were calculated using the inlet loads at station 11A-1 minus all upstream point-source loads. Note that the Concord River non-point loads include the nutrient loads contributed by the Sudbury River for which flow data were not provided, though the stream was sampled at station 11B-1. However, estimates of the Sudbury River loads were made by subtracting the sum of the Assabet River loads at the outlet of Maynard Impoundment (station 04A-1) and the intervening point-source loads of the City of Maynard and the Concord Reformatory from the Concord River inlet loads measured at station 11A-1. The estimated loads derived in this way are shown in parentheses in the Billerica Impoundment nutrient loadings tables (pages 27 and 31).

The operators of the Westboro, Maynard, Marlboro Westerly, and Billerica House of Correction wastewater treatment plants provided monthly effluent samples and corresponding flow data. The operator of the Concord Reformatory plant provided effluent samples but no flow data. Nutrient loads from this source were determined using mean daily flow estimates provided by the Massachusetts Division of Water Pollution Control (Hogan, 1975).

A. Waste Sources†:

1. Northboro Impoundment -

a. Known municipal -

Name	Pop. Served	Treatment	Mean Flow (mgd)	Receiving Water
Westboro	5,000	ext. aer. + sand fltrs.	0.779	Assabet River
Shrewsbury	9,000	trickling filter	1.711	Assabet River

b. Industrial - Unknown

2. Hudson Impoundment -

a. Known municipal -

Name	Pop. Served	Treatment	Mean Flow (mgd)	Receiving Water
Marlboro Westerly	15,000	act. sludge	1.238	Assabet River

Indirect Sources:
Westboro
Shrewsbury

b. Industrial - Unknown

† Cady, 1973; Hogan, 1975.

3. Maynard Impoundment -

a. Known municipal -

Name	Pop. Served	Treatment	Mean Flow (mgd)	Receiving Water
Hudson	10,000	trickling filter	1.301	Assabet River

Indirect Sources:
Westboro
Shrewsbury
Marlboro Westerly

b. Industrial - Unknown

4. Billerica Impoundment -

a. Known municipal -

Name	Pop. Served	Treatment	Mean Flow (mgd)	Receiving Water
Maynard	8,500	trickling filter	0.800	Assabet River
Concord Reformatory	1,000	int. sand filters	0.120	Assabet River
Concord Municipal	5,000	int. sand filters	0.873	Concord River
Billerica House of Corr.	500	trickling filter	0.069	Unnamed trib. to Billerica Imp.

Indirect Sources:
Westboro
Shrewsbury
Marlboro Westerly
Hudson

b. Industrial - Unknown

B. Annual Total Phosphorus Loading - Average Year:

1. Northboro Impoundment -

a. Inputs -

Source	lbs P/yr	% of total
1) Tributaries (non-point load) -		
Assabet River	8,100	15.1
Cold Harbor Brook	840	1.6
2) Minor tributaries & immediate drainage (non-point load) -	470	0.9
3) Known municipal STP's -		
Westboro	11,580	21.5
Shrewsbury	32,780	60.9
4) Septic tanks - Unknown	?	-
5) Industrial - Unknown	?	-
6) Direct precipitation* -	10	<0.1
Total	53,780	100.0

b. Outputs -

Lake outlet - Assabet River 53,610

c. Net annual P accumulation - 170 pounds

* See Working Paper No. 1.

2. Hudson Impoundment -

a. Inputs -

Source	lbs P/ yr	% of total
1) Tributaries (non-point load) -		
Assabet River	10,050	15.1
2) Minor tributaries & immediate drainage (non-point load) -	1,050	1.6
3) Known municipal STP's -		
Marlboro Westerly	11,240	16.9
Westboro*	11,530	17.3
Shrewsbury*	32,650	49.1
4) Septic tanks - Unknown	?	-
5) Industrial - Unknown	?	-
6) Direct precipitation** -	10	<0.1
Total	66,530	100.0

b. Outputs -

Lake outlet - Assabet River 52,000

c. Net annual P accumulation - 14,530 pounds

* Indirect source; adjusted for retention in Northboro Impoundment.
** See Working Paper No. 1.

3. Maynard Impoundment -

a. Inputs -

Source	lbs P/ yr	% of total
1) Tributaries (non-point load) -		
Assabet River	1,760	2.5
Assabet Brook	1,920	2.7
Taylor Brook	920	1.3
2) Minor tributaries & immediate drainage (non-point load) -	1,090	1.5
3) Known municipal STP's -		
Hudson	24,830	35.1
Marlboro Westerly*	8,790	12.4
Westboro*	9,020	12.8
Shrewsbury*	22,270	31.5
4) Septic tanks - Unknown	?	-
5) Industrial - Unknown	?	-
6) Direct precipitation** -	10	<0.1
Total	70,650	100.0

b. Outputs -

Lake outlet - Assabet River 75,750

c. Net annual P loss - 5,100 pounds

* Indirect source; adjusted for retention in upstream impoundments.
** See Working Paper No. 1.

4. Billerica Impoundment -

a. Inputs -

Source	lbs P/ yr	% of total
1) Tributaries (non-point load) -		
Concord River	60,600	38.0
(Sudbury River	49,760*)	
2) Minor tributaries & immediate drainage (non-point load) -	2,510	1.6
3) Known municipal STP's -		
Maynard	16,340	10.2
Concord Reformatory	1,600	1.0
Concord Municipal	12,550	7.9
Billerica House Corr.	1,150	0.7
Westboro**	9,020	5.6
Shrewsbury**	22,270	13.9
Marlboro Westerly**	8,790	5.5
Hudson**	24,830	15.6
4) Septic tanks - Unknown	?	-
5) Industrial - Unknown	?	-
6) Direct precipitation*** -	10	<0.1
Total	159,670	100.0

b. Outputs -

Lake outlet - Concord River 156,790

c. Net annual P accumulation - 2,880 pounds

* Estimated (see page 21).
** Indirect source; adjusted for retention in upstream impoundments.
*** See Working Paper No. 1.

C. Annual Total Nitrogen Loading - Average Year:

1. Northboro Impoundment -

a. Inputs -

Source	lbs N/ yr	% of total
1) Tributaries (non-point load) -		
Assabet River	93,420	41.1
Cold Harbor Brook	41,950	15.6
2) Minor tributaries & immediate drainage (non-point load) -	23,360	8.7
3) Known municipal STP's -		
Westboro	19,450	7.2
Shrewsbury	73,720	27.4
4) Septic tanks - Unknown	?	-
5) Industrial - Unknown	?	-
6) Direct precipitation* -	140	<0.1
Total	252,040	100.0

b. Outputs -

Lake outlet - Assabet River 271,430

c. Net annual N loss - 19,390 pounds

* See Working Paper No. 1.

2. Hudson Impoundment -

a. Inputs -

Source	lbs N/ yr	% of total
1) Tributaries (non-point load) -		
Assabet River	284,150	66.3
2) Minor tributaries & immediate drainage (non-point load) -	23,360	5.4
3) Known municipal STP's -		
Marlboro Westerly	27,840	6.5
Westboro*	19,450	4.5
Shrewsbury*	73,720	17.2
4) Septic tanks - Unknown	?	-
5) Industrial - Unknown	?	-
6) Direct precipitation** -	280	0.1
Total	428,800	100.0

b. Outputs -

Lake outlet - Assabet River 482,840

c. Net annual N loss - 54,040 pounds

* Indirect source; no retention in Northboro Impoundment.
** See Working Paper No. 1.

3. Maynard Impoundment -

a. Inputs -

Source	lbs N/ yr	% of total
1) Tributaries (non-point load) -		
Assabet River	292,760	43.8
Assabet Brook	104,750	15.7
Taylor Brook	18,670	2.8
2) Minor tributaries & immediate drainage (non-point load) -	60,010	9.0
3) Known municipal STP's -		
Hudson	69,070	10.4
Marlboro Westerly*	27,840	4.2
Westboro*	19,450	2.9
Shrewsbury*	73,720	11.1
4) Septic tanks - Unknown	?	-
5) Industrial - Unknown	?	-
6) Direct precipitation** -	770	0.1
Total	667,040	100.0

b. Outputs -

Lake outlet - Assabet River 728,670

c. Net annual N loss - 61,630 pounds

* Indirect source; no retention in upstream impoundments.
** See Working Paper No. 1.

4. Billerica Impoundment -

a. Inputs -

Source	lbs N/ yr	% of total
1) Tributaries (non-point load) -		
Concord River	1,686,620	79.4
(Sudbury River	1,148,030*)	
2) Minor tributaries & immediate drainage (non-point load) -	136,360	6.4
3) Known municipal STP's -		
Maynard	74,520	3.5
Concord Reformatory	8,310	0.4
Concord Municipal	26,120	1.2
Billerica House of Corr.	2,710	0.1
Westboro**	19,450	0.9
Shrewsbury**	73,720	3.5
Marlboro Westerly**	27,840	1.3
Hudson**	69,070	3.2
4) Septic tanks - Unknown	?	-
5) Industrial - Unknown	?	-
6) Direct precipitation*** -	240	<0.1
Total	2,125,460	100.0

b. Outputs -

Lake outlet - Concord River 2,335,060

c. Net annual N loss - 209,600 pounds

* Estimated (see page 21).
** Indirect source; no retention in upstream impoundments.
*** See Working Paper No. 1.

D. Mean Annual Non-point Nutrient Export by Subdrainage Area:

Tributary	lbs P/mi^2/yr	lbs N/mi^2/yr
Assabet River (above Northboro Imp.)	399	4,602
Cold Harbor Brook	87	4,325
Taylor Brook	200	4,059
Assabet Brook	96	5,264
Concord River	242	6,746

E. Yearly Loading Rates:

In the following table, the existing phosphorus loading rates are compared to those proposed by Vollenweider (in press). Essentially, his "dangerous" rate is the rate at which the receiving water would become eutrophic or remain eutrophic; his "permissible" rate is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic rate would be considered one between "dangerous" and "permissible".

Note that Vollenweider's model may not be applicable to water bodies with very short hydraulic retention times.

	Total Phosphorus		Total Nitrogen	
	lbs/acre/yr	$g/m^2/yr$	lbs/acre/yr	$g/m^2/yr$
Northboro	3,585	402	16,803	1,883
Hudson	2,118	249	14,293	1,502
Maynard	1,883	99	8,338	935
Billerica	6,387	716	85,018	9,529

Vollenweider loading rates for phosphorus ($g/m^2/yr$) based on mean depth and mean hydraulic retention times of the four impoundments:

	"Dangerous" (Eutrophic Rate)	"Permissible" (Oligotrophic rate)
Northboro	5.20	2.60
Hudson	5.30	2.65
Maynard	4.00	2.00
Billerica	12.40	6.20

VI. LITERATURE REVIEWED

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Hogan, Paul, 1975. Personal communication (locations and characteristics of STP's). MA Divn. Water Poll. Contr., Westboro.

Vollenweider, Richard A. (in press). Input-output models. Schweiz. Z. Hydrol.

VII. APPENDICES

APPENDIX A

TRIBUTARY FLOW DATA

TRIBUTARY FLOW INFORMATION FOR MASSACHUSETTS 11/26/74

LAKE CODE 2512 NORTHBORO IMPOUNDMENT

TOTAL DRAINAGE AREA OF LAKE 35.40

TRIBUTARY	SUB-DRAINAGE AREA	NORMALIZED FLOWS JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
2512A1	35.40	60.90	67.30	121.00	114.00	72.20	38.90	17.80	18.70	19.90	23.20	43.90	49.90	53.86
2512A2	20.30	34.90	38.60	69.20	65.60	41.40	22.30	10.20	10.70	11.40	13.30	25.20	28.60	30.89
2512B1	9.70	16.70	18.40	33.10	31.30	19.80	10.70	4.90	5.10	5.50	6.40	12.00	13.70	14.77
2512Z2	5.40	9.30	10.30	18.40	17.40	11.00	5.90	2.70	2.90	3.00	3.50	6.70	7.60	8.21

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 35.40
SUM OF SUB-DRAINAGE AREAS = 35.40

TOTAL FLOW IN = 647.70
TOTAL FLOW OUT = 647.70

MEAN MONTHLY FLOWS AND DAILY FLOWS

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
2512A1	9	72	17.50	9	21.30				
	10	72	27.10	14	24.50				
	11	72	108.00						
	12	72	125.00	9	193.00				
	1	73	110.00	13	58.40				
	2	73	110.00	10	116.00				
	3	73	94.60	10	198.00	23	97.70		
	4	73	148.00	14	124.00	28	121.00		
	5	73	80.10	12	95.20				
	6	73	51.30	9	37.50				
	7	73	59.10	14	54.20				
	8	73	32.20	26	15.30				
2512A2	9	72	10.00	9	12.20				
	10	72	15.60	14	14.10				
	11	72	62.20						
	12	72	71.50	9	110.00				
	1	73	62.80	13	33.50				
	2	73	62.90	10	66.60				
	3	73	54.10	10	113.00	23	56.00		
	4	73	85.30	14	71.00	28	69.60		
	5	73	46.00	12	54.60				
	6	73	29.40	9	21.50				
	7	73	33.90	14	31.10				
	8	73	18.40	26	8.70				

TRIBUTARY FLOW INFORMATION FOR MASSACHUSETTS 11/26/74

LAKE CODE 2512 NORTHBORO IMPOUNDMENT

MEAN MONTHLY FLOWS AND DAILY FLOWS

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
251281	9	72	4.80	9	5.80				
	10	72	7.50	14	6.70				
	11	72	29.60						
	12	72	34.20	9	52.80				
	1	73	30.10	13	16.00				
	2	73	30.00	10	31.80				
	3	73	25.90	10	54.20	23	26.80		
	4	73	40.70	14	34.00	28	33.30		
	5	73	22.00	12	26.10				
	6	73	14.10	9	10.30				
	7	73	16.30	14	14.80				
	8	73	8.80	26	4.20				
251277	9	72	2.60						
	10	72	4.10						
	11	72	16.50						
	12	72	19.00						
	1	73	16.70						
	2	73	16.80						
	3	73	14.40						
	4	73	22.60						
	5	73	12.20						
	6	73	7.80						
	7	73	9.00						
	8	73	5.00						

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TRIBUTARY FLOW INFORMATION FOR MASSACHUSETTS 11/26/74

LAKE CODE 2513 HUDSON IMPOUNDMENT

TOTAL DRAINAGE AREA OF LAKE 72.70

TRIBUTARY	SUB-DRAINAGE AREA	NORMALIZED FLOWS JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
251341	60.60	104.00	115.00	207.00	196.00	124.00	66.70	30.50	32.00	34.10	39.70	75.10	85.40	92.27
251342	72.70	125.00	138.00	248.00	235.00	148.00	80.00	36.60	38.40	40.90	47.60	90.10	103.00	110.65
251377	12.10	20.90	23.00	41.30	39.10	24.70	13.30	6.10	6.40	6.80	7.90	15.00	17.10	18.42

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 72.70
SUM OF SUB-DRAINAGE AREAS = 72.70

TOTAL FLOW IN = 1331.00
TOTAL FLOW OUT = 1330.60

MEAN MONTHLY FLOWS AND DAILY FLOWS

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
251341	9	72	30.00	9	36.50				
	10	72	46.40	14	42.00				
	11	72	185.00						
	12	72	214.00	9	330.00				
	1	73	187.00	13	100.00				
	2	73	187.00	10	199.00				
	3	73	162.00	10	239.00	24	164.00		
	4	73	255.00	14	212.00	28	208.00		
	5	73	138.00	12	163.00				
	6	73	88.00	9	64.20				
	7	73	131.00						
	8	73	55.00						
251342	9	72	36.00	9	43.80				
	10	72	55.70	14	50.40				
	11	72	223.00						
	12	72	258.00	9	395.00				
	1	73	225.00	13	120.00				
	2	73	225.00						
	3	73	194.00	10	400.00	24	196.00		
	4	73	306.00	14	254.00	28	249.00		
	5	73	164.00	12	196.00				
	6	73	106.00	9	77.00				
	7	73	122.00						
	8	73	66.00						
251377	9	72	6.00						
	10	72	9.20						
	11	72	37.00						
	12	72	42.80						
	1	73	37.40						
	2	73	37.50						
	3	73	32.30						
	4	73	50.80						
	5	73	27.40						
	6	73	17.60						
	7	73	20.00						
	8	73	11.00						

TRIBUTARY FLOW INFORMATION FOR MASSACHUSETTS 11/26/74

LAKE CODE 2504 MAYNARD IMPOUNDMENT

TOTAL DRAINAGE AREA OF LAKE 113.00

TRIBUTARY	SUB-DRAINAGE AREA	NORMALIZED FLOWS JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
2504A1	113.00	194.00	215.00	385.00	365.00	231.00	124.00	56.80	59.70	63.50	74.00	140.00	159.00	171.89
2504A3	77.10	133.00	146.00	263.00	249.00	157.00	84.80	38.80	40.70	43.30	50.50	95.60	109.00	117.32
2504B1	4.60	7.90	8.70	15.70	14.90	9.40	5.10	2.30	2.40	2.60	3.00	5.70	6.50	7.00
2504C1	19.90	34.20	37.80	67.90	64.30	40.60	21.90	10.00	10.50	11.20	13.00	24.70	28.10	30.29
2504Z2	11.40	19.60	21.70	38.90	36.80	23.30	12.50	5.70	6.00	6.40	7.50	14.10	16.10	17.35

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 113.00
SUM OF SUB-DRAINAGE AREAS = 113.00

TOTAL FLOW IN = 2067.70
TOTAL FLOW OUT = 2067.00

MEAN MONTHLY FLOWS AND DAILY FLOWS

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
2504A1	9	72	55.80	9	68.10				
	10	72	86.60	14	78.30				
	11	72	346.00						
	12	72	398.00	9	615.00				
	1	73	349.00	13	186.00				
	2	73	350.00	10	371.00				
	3	73	301.00	10	632.00	24	305.00		
	4	73	474.00	14	396.00	28	388.00		
	5	73	256.00	12	304.00				
	6	73	164.00	9	120.00				
	7	73	189.00						
	8	73	103.00						
2504A3	9	72	38.10	9	46.50				
	10	72	59.10	14	53.40				
	11	72	236.00						
	12	72	272.00	9	419.00				
	1	73	239.00	13	127.00				
	2	73	238.00	10	253.00				
	3	73	206.00	10	431.00	24	208.00		
	4	73	324.00	14	270.00	28	264.00		
	5	73	174.00	12	207.00				
	6	73	112.00	9	81.70				
	7	73	129.00						
	8	73	70.00						

TRIBUTARY FLOW INFORMATION FOR MASSACHUSETTS 11/26/74

LAKE CODE 2504 MAYNARD IMPOUNDMENT

MEAN MONTHLY FLOWS AND DAILY FLOWS

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
2504R1	9	72	2.30	9	2.80				
	10	72	3.50	14	3.20				
	11	72	14.10						
	12	72	16.20						
	1	73	14.20	13	7.60				
	2	73	14.20	10	15.10				
	3	73	12.30	0	0.0				
	4	73	19.40	14	16.10	28	15.80		
	5	73	10.40	12	12.40				
	6	73	6.70	9	4.90				
	7	73	7.60						
	8	73	4.10						
2504C1	9	72	9.80	9	12.00				
	10	72	15.20	14	13.80				
	11	72	61.00						
	12	72	70.20						
	1	73	61.60	13	22.80				
	2	73	61.60	10	65.30				
	3	73	53.10	0	0.0				
	4	73	83.60	14	69.60	28	68.30		
	5	73	45.10	12	53.50				
	6	73	28.90	9	21.10				
	7	73	33.20						
	8	73	18.10						
2504Z7	9	72	5.60						
	10	72	8.80						
	11	72	34.80						
	12	72	40.20						
	1	73	35.30						
	2	73	35.40						
	3	73	30.40						
	4	73	47.80						
	5	73	25.90						
	6	73	16.50						
	7	73	18.90						
	8	73	10.30						

TRIBUTARY FLOW INFORMATION FOR MASSACHUSETTS 11/26/74

LAKE CODE 2511 HILLERICA IMPOUNDMENT

TOTAL DRAINAGE AREA OF LAKE 276.00

TRIBUTARY	SUB-DRAINAGE AREA	NORMALIZED FLOWS JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
2511A1	250.00	549.00	652.00	1030.00	1036.00	632.00	370.00	215.00	204.00	222.00	242.00	406.00	510.00	504.43
2511A3	276.00	588.00	699.00	1104.00	1115.00	681.00	399.00	231.00	218.00	238.00	259.00	434.00	548.00	541.68
2511Z7	26.00	39.40	46.40	75.10	78.50	49.40	29.10	15.70	14.00	15.70	17.50	28.10	37.70	37.16

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 276.00
SUM OF SUB-DRAINAGE AREAS = 276.00

TOTAL FLOW IN = 6514.88
TOTAL FLOW OUT = 6516.00

MEAN MONTHLY FLOWS AND DAILY FLOWS

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
2511A1	9	72	174.00	9	187.00				
	10	72	252.00	14	391.00				
	11	72	870.00						
	12	72	275.00	9	1482.00				
	1	73	988.00	13	734.00				
	2	73	1043.00	10	1029.00				
	3	73	866.00	10	933.00	24	871.00		
	4	73	1140.00	14	1338.00	28	923.00		
	5	73	784.00	12	768.00				
	6	73	481.00	9	442.00				
	7	73	666.00	14	377.00				
	8	73	302.00	11	302.00				
2511A3	9	72	187.00	9	201.00				
	10	72	269.00	14	421.00				
	11	72	877.00						
	12	72	1370.00	9	1594.00				
	1	73	1058.00	13	790.00				
	2	73	1118.00	10	1107.00				
	3	73	930.00	10	1004.00	24	937.00		
	4	73	1226.00	14	1439.00	28	993.00		
	5	73	844.00	12	827.00				
	6	73	519.00	9	476.00				
	7	73	718.00	14	406.00				
	8	73	323.00	11	325.00				
2511Z7	9	72	12.30						
	10	72	18.20						
	11	72	56.80						
	12	72	94.20						
	1	73	70.70						
	2	73	74.30						
	3	73	63.20						
	4	73	84.40						
	5	73	61.20						
	6	73	37.80						
	7	73	48.70						
	8	73	30.70						

APPENDIX B

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 74/04/10

251201
42 19 30.0 071 38 00.0
NORTHBORO IMPOUNDMENT
25 MASSACHUSETTS

11EPALES
4

2111202
0005 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/03/03	08 45	0000	16.4	6.3	42	20	6.50	10K	0.350	0.250	0.275	0.212

K VALUE KNOWN TO BE LESS
THAN INDICATED

STORET RETRIEVAL DATE 74/11/26

251301
42 24 30.0 071 32 00.0
HUDSON IMPOUNDMENT
25 MASSACHUSETTS

11EPALES
4

2111202
0006 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/06/02	09 20 0000		17.2	11.7	42	130	6.40	10K	0.260	0.170	0.153	0.136
72/08/04	14 30 0000				60	220	6.50	31	0.530	0.780	0.476	0.416
	14 30 0004		24.1	6.2		215	6.60	29	0.500	0.720	0.466	0.385
72/10/06	13 55 0000				58	255	6.45	18	1.760	0.090	1.230	1.230
	13 55 0003		14.9	7.6		250	6.55	20	1.860	0.080	1.170	1.160

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/06/02	09 20 0000		2.5J
72/08/04	14 30 0000		1.3J
72/10/06	13 55 0000		2.9J

K VALUE KNOWN TO BE LESS THAN INDICATED

J VALUE KNOWN TO BE IN ERROR

STORET RETRIEVAL DATE 74/ 1/26

250401
42 25 34.0 071 28 11.0
MAYNARD IMPOUNDMENT
25 MASSACHUSETTS

11EPALES
3

2111202
0005 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/06/02	09 00	0000	17.7	4.7	36	120	6.30	10K	0.220	0.190	0.214	0.135
72/08/04	14 00	0000			60	178	6.55	24	0.280	0.180	0.262	0.195
	14 00	0004	22.8	4.2		160	6.40	27	0.630	7.400	0.337	0.596
72/10/06	14 15	0000			72	205	6.40	25	0.950	0.100	0.474	0.427
	14 15	0004	14.6	6.2		200	6.40	12	0.420	0.120	0.417	0.356

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/06/02	09 00	0000	2.2J
72/08/04	14 00	0000	41.5J
72/10/06	14 15	0000	7.1J

K VALUE KNOWN TO BE LESS THAN INDICATED

J VALUE KNOWN TO BE IN ERROR

STORET RETRIEVAL DATE 74/11/26

250402
42 25 07.0 071 29 30.0
MAYNARD IMPOUNDMENT
25 MASSACHUSETTS

11EPALES
3

2111202
0005 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/08/04	14	15 0000			36	190	6.50	25	0.390	0.240	0.321	0.251
	14	15 0004	23.9	4.6		187	6.45	24	0.380	0.280	0.942	0.222
72/10/06	14	25 0000			58	240	6.35	22	1.300	0.130	0.630	0.590
	14	25 0004	14.8	6.2		240	6.30	23	1.250	0.150	0.820	0.550

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/10/06	14	25 0000	5.4J

J VALUE KNOWN TO BE IN ERROR

STORET RETRIEVAL DATE 74/11/26

251101
42 35 30.0 071 17 00.0
BILLERICA IMPOUNDMENT
25 MASSACHUSETTS

11EPALES
4

2111202
0010 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/06/08	17 50	0000	19.5	5.6	48	160	6.40	10	0.200	0.170	0.172	0.131
	17 50	0010	19.7	4.6		160	6.50	10K	0.190	0.160	0.190	0.125
72/08/04	15 00	0000				240	6.90	23	0.290	0.190	0.220	0.142
	15 00	0004	24.5	4.8		200	6.50	21	0.240	0.210	0.232	0.176
	15 00	0008	24.4	9.0		185	6.50	24	0.300	0.200	0.250	0.160
72/10/06	15 25	0000			32	210	8.15	23	0.320	0.070	0.151	0.078
	15 25	0004	16.9	9.0		215	7.05	28	0.290	0.100	0.155	0.063
	15 25	0007	16.5	10.6		215	7.30	23	0.330	0.070	0.158	0.071

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/06/08	17 50	0000	0.9J
72/08/04	15 00	0000	17.5J
72/10/06	15 25	0000	18.3J

K VALUE KNOWN TO BE LESS THAN INDICATED

J VALUE KNOWN TO BE IN ERROR

APPENDIX C

TRIBUTARY and WASTEWATER TREATMENT PLANT DATA

STORET RETRIEVAL DATE 74/11/26

2512A1 LS2512A1
42 20 30.0 071 37 00.0
ASSABET RIVER
25 7.5 MARLBOROUGH
O/NORTHBORO IMP.
BOUNDRY ST BROG NE OF CHAPINVILLE
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/09/09	10 45		2.100	0.835	0.115	1.260	1.370
72/10/14	15 09		0.880	1.100	0.357	0.320	0.600
72/12/09			0.660	0.690	0.150	0.072	0.138
73/02/10	10 15		0.710	2.310	0.270	0.126	0.190
73/03/10	09 00		0.600	1.600	0.280	0.168	0.230
73/03/23	07 45		0.750	1.500	0.450	0.230	0.315
73/05/12	07 55		0.610	3.100	0.270	0.220	0.315
73/06/09	08 15		1.380	2.800	0.240	0.580	0.700
73/07/14	08 30		0.820	0.900	0.100	0.315	0.425
73/08/26	11 30		1.540	0.750	0.054	0.700	0.800

STORET RETRIEVAL DATE 74/11/26

2512A2 LS2512A2
42 19 30.0 071 38 00.0
ASSABET RIVER
25 7.5 SHREWSBURY
I/NORTHBORO IMP.
US 20 BRDG ABOV MARLBOROUGHSTP
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/09/09	11 05		1.370	2.100	1.020		1.400
72/10/14	15 21		0.977	2.200	0.680	0.640	0.950
72/12/09	09 10		0.760	1.680	0.280	0.092	0.176
73/03/10	09 20		0.650	1.200	0.410	0.280	0.390
73/03/23	08 05		0.870	1.540	0.650	0.450	0.590
73/04/28	07 50		0.630	1.600	0.380	0.294	0.430
73/05/12	08 40		0.560	2.800	0.580	0.320	0.480
73/06/09	08 25		1.600	3.890	1.600	1.580	1.720
73/07/14	08 40		0.450	1.340	0.610	0.550	0.790
73/08/28	11 45		1.020	3.400	2.500	1.470	1.720

STORET RETRIEVAL DATE 74/11/26

2512A3 LS2512A3
42 17 30.0 071 38 30.0
ASSABET RIVER
25 7.5 SHREWSBURY
I/NORTHBORO IMP
ST HWY 135 BRDG BELO SHREWSBURY STP
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/09/09			1.827	3.400	1.330		2.100
72/10/14	15 25		0.960	2.700	1.200	0.810	1.575
72/12/09	09 20		0.680	1.680	0.240	0.066	0.130
73/01/13	09 40		0.580	1.400	0.590	0.260	0.345
73/02/10	10 45		0.670	1.700	0.440	0.220	0.330
73/03/10	09 30		0.490	2.200	0.440	0.240	0.340
73/03/23	08 15		0.600	1.800	0.570	0.370	0.470
73/04/28	08 00		0.280	2.200	0.570	0.198	0.310
73/05/12	08 50		0.330	2.100	0.490	0.240	0.375
73/06/09	08 30		1.100	2.800	0.990	1.040	1.250
73/07/14	09 00		0.430	1.800	0.350	0.370	0.700
73/08/26	12 00		0.880	3.100	1.600	1.300	1.700

STORET RETRIEVAL DATE 74/11/26

2512A4 LS2512A4
42 17 00.0 071 38 30.0
ASSABET RIVER
25 7.5 SHREWSBURY
I/NORTHBORO IMP
ST HWY 9 BRDG BELO WESTBOROSTP
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/09/09	11 20		1.300	2.600	1.000		1.260
72/10/14	15 45		0.830	1.600	0.380	0.415	0.835
72/12/04	09 25		0.490	1.000	0.147	0.056	0.138
73/01/11	09 53		0.530	1.150	0.340	0.180	0.260
73/02/10	10 30		0.600	1.470	0.330	0.180	0.260
73/03/10	10 00		0.450	1.400	0.140	0.180	0.240
73/03/23	08 40		0.590	0.990	0.067	0.240	0.315
73/04/28	08 50		0.168	2.500	0.115	0.170	0.280
73/05/12	09 10		0.120	2.520	0.310	0.200	0.270
73/06/09	08 55		1.380	1.150	0.200	0.785	0.860
73/07/14	09 30		0.032	1.600	0.260	0.054	0.490
73/08/26	12 15		0.700	2.900	1.100	0.860	1.100

52

STORET RETRIEVAL DATE 74/11/26

2512A5 LS2512A5
42 17 00.0 071 38 00.0
ASSABET RIVER
25 7.5 SHREWSBURY
I/NORTHBORO IMP.
MAYNARD ST BRDG ABOVE WESTBORO-STP
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/09/09	11 30		0.105		1.055	0.300	0.345
72/10/14	15 35		0.162	1.450	0.420	0.020	0.164
72/12/09	09 10		0.300	1.200	0.150	0.010	0.068
73/01/13	09 50		0.300	1.980	0.420	0.040	0.090
73/02/10	11 00		0.410	1.050	0.176	0.012	0.055
73/03/10	09 42		0.340	1.200	0.067	0.012	0.045
73/03/23	08 25		0.189	0.800	0.030	0.007	0.047
73/04/14	08 50		0.028	2.100	0.054	0.010	0.055
73/04/28	08 20		0.023	1.600	0.033	0.016	0.070
73/05/12	08 55		0.048	1.600	0.126	0.021	0.050
73/06/09	08 35		0.069	1.540	0.154	0.019	0.065
73/07/14	09 10		0.176	1.600	0.098	0.022	0.140
73/08/26	12 10		0.088	3.570	1.160	0.169	0.550

STORET RETRIEVAL DATE 74/11/26

2512R1 LS2512R1
42 19 30.0 071 38 30.0
COLD HARBOR BROOK
25 7.5 SHREWSHURY
T/NORTHBORO IMP.
HUDSON ST BRDG
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/09/09	11 00		0.299	0.600	0.120	0.015	0.062
72/10/14	15 15		0.260	0.600	0.138	0.027	0.094
72/12/09	08 35		0.330	1.260	0.095	0.005K	0.008
73/01/13	09 30		0.610	0.320	0.040	0.005	0.005
73/02/10	10 40		0.390	1.540	0.080	0.005K	0.010
73/03/10	09 10		0.270	1.200	0.065	0.007	0.015
73/03/23	07 55		0.336	1.050	0.060	0.007	0.015
73/04/14	08 05		0.231	1.600	0.100	0.006	0.010
73/04/24	07 40		0.180	3.100	0.126	0.008	0.015
73/05/12	08 30		0.140	1.380	0.066	0.011	0.025
73/06/09	08 20		0.200	1.000	0.088	0.011	0.030
73/07/14	08 35		0.370	0.610	0.520		0.045
73/08/26	11 35		0.220	0.400	0.025	0.010	0.035

54

STORET RETRIEVAL DATE 74/11/26

2512C1 LS2512C1
42 16 30.0 071 39 00.0
HOCOMONCO POND OUTLET
25 7.5 SHREWSBORO
T/NORTHBORO IMP.
OTIS ST BRDG ABOV WESTBORO STP
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/09/09	11 35		0.026	0.325	0.054	0.015	0.029
72/10/14	15 40		0.093	0.500	0.075	0.005K	0.010
72/12/09	09 35		0.430	1.900	0.075	0.005K	0.010
73/01/13	10 00		0.850	0.900	0.060	0.005K	0.015
73/02/10	09 00		0.660	1.100	0.068	0.005K	0.015
73/03/10	09 50		0.610	1.800	0.063	0.005K	0.015
73/03/23	08 30		0.370	0.650	0.028	0.010	0.015
73/04/14	08 50		0.154	1.500	0.260	0.005K	0.015
73/04/28	08 10		0.058	1.150	0.054	0.006	0.010
73/05/12	09 00		0.033	1.150	0.060	0.008	0.030
73/06/09	08 45		0.085	0.880	0.066	0.006	0.020
73/07/14	09 20		0.740	0.660		0.029	0.030
73/09/26	12 10		0.048	0.170	0.018	0.006	0.015

K VALUE KNOWN TO BE IN ERROR, VALUE IS LESS THAN GIVEN VALUE

STORET RETRIEVAL DATE 74/11/27

251250 TP251250 P005500
42 17 30.0 071 38 30.0
SHREWSBURY
25027 7.5 SHREWSBURY
T/NORTHBORO IMPOUNDMENT
ASSABETT RIVER
11EPALLS 2141204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
73/08/02	08 30		3.310	3.600	3.310	5.100	6.800	1.100	1.200
73/09/07	13 15			14.000				1.250	1.280
73/10/31	12 45		4.700	15.800	7.300	9.400	10.500	1.100	1.150
73/12/31	12 50		3.700	16.000	6.000	5.300	7.100	1.000	1.070
73/11/27	10 40		3.100	15.500	7.000	7.700	8.900	1.600	1.150
73/12/27	14 00		2.310	6.350	1.700	1.300	2.100	3.000	2.520
74/02/01	11 40		2.000	12.000	4.200	3.100	5.100	2.700	2.700
74/03/01	09 30		1.200	8.200	2.600	3.700	5.600	2.200	2.000
74/04/01	09 00		1.127	7.450	2.000	2.200	3.130		2.000
74/05/01	08 45		0.440	12.000	3.700	3.700	5.100	1.800	2.000
74/06/04	09 20		2.040	16.000	5.100	6.300	7.400	1.550	1.610

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STORET RETRIEVAL DATE 74/11/27

251251 AS251251 P007500
42 17 00.0 071 38 30.0
WESTBORO
25 7.5 SHREWSBURY
T/NORTHBORO IMPOUNDMENT
ASSABETT RIVER
11EPALES 2141204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
72/12/27	09 00								
CP(T)-			3.700	3.000	0.645	4.200	4.200	0.890	0.900
72/12/28	09 00								
73/01/30	07 00								
CP(T)-			6.000	1.890	1.075	3.600	3.800	0.792	0.759
73/01/30	17 00								
73/02/25	00 00								
CP(T)-			6.000	1.540	0.450	5.900	6.100	0.550	0.676
73/02/28	08 00								
73/03/30	07 00								
CP(T)-			1.400	9.100	4.800	5.100	5.100	0.615	0.624
73/03/30	15 00								
73/04/30	07 00								
CP(T)-			1.840	5.500	2.400	5.100	5.250	0.655	0.794
73/04/30	15 00								
73/05/30	07 00								
CP(T)-			4.600			3.400	6.000	0.645	0.705
73/05/30	15 00								
73/06/29	08 00								
CP(T)-			1.500	1.530	0.340	5.100	5.600	0.745	0.584
73/06/29	15 00								
73/07/31	07 00								
CP(T)-			1.540	0.300	0.094	3.300	5.920	0.822	0.904
73/07/31	16 00								
73/08/31	07 00								
CP(T)-				1.380	0.110	6.300	7.000	0.770	0.804
73/08/31	15 00								
73/09/28	07 00								
CP(T)-			15.000	2.400	0.090	9.600	9.800	0.802	0.805
73/09/29	14 00								
73/10/31	07 00								
CP(T)-			5.900	3.000	0.300	1.540	1.800	0.745	0.730
73/10/31	14 00								
73/11/29	07 30								
CP(T)-			0.230	12.000	3.900	3.200	3.700	0.754	0.742
73/11/29	14 30								

STORET RETRIEVAL DATE 74/11/27

251251 AS251251 P007500
42 17 00.0 071 38 30.0
#ESTHORO
25 7.5 SHREWSBURY
T/NORTHBORO IMPOUNDMENT
ASSABETT RIVER
11EPALES 2141204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
73/12/28 07 00 CP(T)- 73/12/28 14 00			0.330	6.900	1.760	0.560	1.600	1.260	1.100

85

STORET RETRIEVAL DATE 74/11/26

2513A1 LS2513A1
42 23 00.0 071 35 00.0
ASSABET RIVER
25127 7.5 HUDSON
I/HUDSON IMP.
CHAPIN RD BRDG BELO MARLBOROUGH STP
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/09/09	10 05		1.430	1.980	0.160	1.050	1.160
72/12/09	09 30		0.620	0.630	0.094	0.063	0.100
73/01/13	12 14		0.840	1.050	0.330	0.092	0.170
73/03/10	08 30		0.470	0.420	0.168	0.110	0.150
73/03/24	09 00		0.520		0.190	0.140	0.195
73/04/14	09 50		0.480	3.000	0.170		0.233
73/04/28			0.378	1.320	0.066	0.120	0.160
73/05/12	11 55		0.440	0.660	0.086	0.160	0.215
73/06/09	10 00		0.410	3.360	0.252	0.231	0.340

STORET RETRIEVAL DATE 74/11/26

2513A2 LS2513A2
42 23 00.0 071 33 00.0
ASSABET RIVER
25 7.5 HUDSON
0/HUDSON IMP.
ST HWY 62 BRDG ABOVE HUDSON STP
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/09/09	10 30		0.880	1.050	0.096	0.490	0.570
72/10/14	09 56		0.770	1.950	0.230	0.273	0.357
72/12/09	09 40		0.600	1.000	0.090	0.055	0.088
73/01/13	12 26		0.810	1.050	0.230	0.079	0.155
73/03/10	08 50		0.430	0.915	0.120	0.078	0.110
73/03/24	10 00		0.500	1.260	0.110	0.126	0.160
73/04/14	09 00		0.480	2.970	0.220	0.170	0.220
73/04/28	09 40		0.380	0.780	0.063	0.120	0.165
73/05/12	11 50		0.370	1.900	0.092	0.132	0.180
73/06/09	10 10		0.430	3.330	0.280	0.250	0.330

60

STORET RETRIEVAL DATE 74/11/26

2513A3 LS2513A3
42 24 30.0 071 32 00.0
ASSABET RIVER
25 7.5 HUDSON
O/HUDSON IMP.
ST HWY 62 BRDG BELO HUDSON STP
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/09/09			1.255	1.300	0.475	0.800	0.945
72/10/14	10 02		0.920		0.500		
73/03/10	09 00		0.440	1.000	0.231	0.176	0.220
73/04/14	09 00		0.470	1.760	0.154	0.198	0.220
73/04/28	09 50		0.410	1.800	0.198	0.154	0.210
73/05/12	11 25		0.410	0.840	0.126	0.176	0.240
73/06/09	10 20		0.430	2.700	0.260	0.252	0.330

STORET RETRIEVAL DATE 74/11/27

251350 TF251350 P010000
42 24 00.0 071 32 30.0
HUDSON
25 7.5 HUDSON
T/HUDSON IMPOUNDMENT
ASSABETT RIVER
11EPALES 2141204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
72/11/24	07 00								
CP(T)- 72/11/24	16 00		0.990	4.600	0.180	1.300	2.500	1.250	1.000
72/12/29			2.080	12.130	5.300	2.300	3.350	2.000	2.000
73/02/02	07 00								
CP(T)- 73/02/02	15 00		1.050	14.700	9.600	1.700	4.900	1.300	1.500
73/03/01	07 00								
CP(T)- 73/03/01	16 00		1.400	17.800	10.400	6.000	7.700	1.210	1.300
73/04/02	07 00								
CP(T)- 73/04/02	16 00		1.000	9.500	6.200	2.300	3.600	1.500	1.500
73/04/30	07 00								
CP(T)- 73/04/30	15 00		1.600	18.000	9.050	5.600	7.050	1.500	1.500
73/05/31	07 00								
CP(T)- 73/05/31	16 00		1.750	14.700	9.990	5.470	6.700	1.500	1.500
73/05/29	07 00								
CP(T)- 73/06/29	15 00		2.000	12.200	8.500	5.200	6.600	1.50	1.500
73/07/31	07 00								
CP(T)- 73/07/31	16 00		2.800	12.600	6.700	5.300	6.900	1.000	1.200
73/08/31	08 00								
CP(T)- 73/08/31	15 00			16.000			9.000	0.830	0.910
73/10/01	08 00		0.020	33.600	23.000	10.200	11.000	1.000	1.000
73/10/31	07 00								
CP(T)- 73/10/31	15 00		4.650	19.500	13.700	4.400	8.700	1.010	1.000
73/11/30	07 00								
CP(T)- 73/11/30	15 00		4.800	19.500	11.600	6.300	8.400	1.000	1.000

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STORET RETRIEVAL DATE 74/11/27

251351 AS251351 P005000
42 21 00.0 071 33 00.0
MARLBORO WESTERLY
25 7.5 MARLBORO
T/HUDSON IMPOUNDMENT
ASSABETT RIVER
11EPALES 2141204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
72/11/30	08 00								
CP(T)-			0.880	8.500	0.840	4.275		1.510	0.740
72/11/30	17 00								
72/12/07	08 00								
CP(T)-			0.048	19.000	12.000	0.755		1.600	1.630
72/12/07	17 00								
73/01/03	08 00								
CP(T)-			0.900	5.600	1.680	2.200	2.800	1.800	1.500
73/01/03	16 00								
73/03/16	08 00								
CP(T)-			0.095	6.300	3.550	3.500	3.600	1.350	1.370
73/03/16	17 00								
73/07/02	08 00								
CP(T)-			0.180	2.200	0.670		0.680	1.610	1.260
73/07/03	08 00								
73/08/30	08 30								
CP(T)-			1.920		3.260	5.400		1.300	1.300
73/08/31	08 30								
73/09/25	08 00								
CP(T)-			3.300	2.500	0.045	4.200	4.200	1.270	1.300
73/09/26	08 00								
73/10/11	08 00								
CP(T)-			3.000	1.700	0.120	5.000	5.250	1.170	1.050
73/10/12	08 00								
74/01/04	08 00								
CP(T)-			0.120	9.450	0.120	1.380	1.900	1.150	1.250
74/01/05	08 00								
74/02/19	08 00								
CP(T)-			0.160	6.600	1.700	2.200	2.400	1.090	1.120
74/02/20	08 00								
74/04/16	08 00								
CP(T)-			0.320	2.200	1.250	3.000	3.300	1.530	1.160
74/04/17	08 00								

STORET RETRIEVAL DATE 74/11/26

2504A1 LS2504A1
42 25 30.0 071 28 00.0
ASSABET RIVER
25 7.5 MAYNARD
O/MAYNARD IMPOUNDMENO
ST HWY 62 AND 17 BRDG ABOV MAYNARD STP
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/09/09	12 45		0.697	1.470	0.180	0.022	0.550
72/10/14	10 50		0.480	1.000	0.210	0.220	0.290
72/12/09	10 10		0.470	1.260	0.176	0.056	0.088
73/01/13	13 12		0.730		0.350	0.115	0.160
73/02/10	10 10		0.480	1.150	0.140	0.047	0.070
73/03/10	09 30		0.360	0.490	0.138	0.175	0.220
73/03/24	10 30		0.470	2.300	0.200	0.110	0.155
73/04/14	10 15		0.399	2.200	0.132	0.150	0.200
73/04/28	10 15		0.168	0.590	0.111	0.115	0.155
73/05/12	10 45		0.340	1.500	0.140	0.160	0.210
73/06/09	10 35		0.420	5.000	0.300	0.240	0.320

STORET RETRIEVAL DATE 74/11/26

2504A2 LS2504A2
42 27 00.0 071 24 00.0
ASSABET RIVER
25 7.5 MAYNARD
I/MAYNARD IMP.
ST HWY BRDG BELO MAYNARD STP
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/09/09	12 25		0.540	2.125	0.260	0.510	0.620
72/10/14	10 35		0.650	0.900	0.290	0.273	0.360
72/12/09	10 25		0.470	0.990	0.189	0.054	0.084
73/01/13	13 00		0.760	1.050	0.336	0.120	0.170
73/02/10	09 55		0.510	1.540	0.176	0.058	0.085
73/03/10	10 15		0.410	0.540	0.154	0.138	0.200
73/03/24	10 40		0.470		0.252	0.115	0.175
73/04/14	10 00		0.390	2.310	0.100	0.147	0.195
73/04/28	10 30		0.300	1.500	0.140	0.115	0.160
73/05/12	10 28		0.399	1.540	0.140	0.160	0.240
73/06/09	10 45		0.430	2.500	0.230	0.252	0.330

STORET RETRIEVAL DATE 74/11/26

250443 LS250443
42 24 30.0 071 31 30.0
ASSABET RIVER
25 7.5 HUDSON
I/MAYNARD IMP.
ST HWY 62 BRDG BELO HUDSON STP
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/12/09	09 50		0.590	1.300	0.189	0.078	0.132
73/01/13	12 55		0.740	0.940	0.360	0.087	0.170
73/02/10	09 40		0.570	0.540	0.168	0.084	0.125
73/03/24	09 50		0.510	1.680	0.270	0.168	0.220

STORET RETRIEVAL DATE 74/11/26

250481 LS250481
42 25 30.0 071 28 00.0
TAYLOR BROOK
25 7.5 MAYNARD
T/MAYNARD IMP.
BRDG OFS ST HWY 117 SW EDGEOF MAYNARD
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/09/09	11 10		0.162	0.700	0.173	0.025	0.060
72/10/14	10 20		0.070	0.600	0.072	0.008	0.027
73/03/24	10 15		0.054	1.680	0.090	0.011	0.020
73/04/28	10 00		0.290	0.710	0.092	0.110	0.150
73/05/12	11 05		0.044	1.600	0.110	0.069	0.082
73/06/09	11 01		0.060	2.200	0.204	0.031	

STORET RETRIEVAL DATE 74/11/26

2504C1 LS2504C1
42 25 00.0 071 28 30.0
ASSABET BROOK
25 7.5 MAYNARD
T/MAYNARD IMP.
BRDG NEAR GOLF COURSE W SIDE OF RIVER
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/09/09	11 05		0.400	1.150	0.105	0.012	0.028
72/10/14	10 45		0.250	0.700	0.053	0.007	0.017
73/04/28	10 05		0.150	0.700	0.069	0.012	0.030
73/05/12	10 30		0.160	1.890	0.081	0.012	0.035
73/06/09	10 55		0.132	3.360	0.170	0.017	0.055

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STORET RETRIEVAL DATE 74/11/27

251153 TF251153 P009700
42 26 30.0 071 26 30.0
MAYNARD
25 7.5 MAYNARD
T/MAYNARD IMPOUNDMENT
ASSABETT RIVER
11EPALES 2141204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
72/11/29	11 00								
CP(T)-			0.440	33.000	11.200	4.775		0.800	0.800
72/11/29	16 00								
72/12/29	11 00								
CP(T)-			1.500	25.000	7.200	3.500	9.100	0.800	0.800
72/12/29	16 00								
73/01/30	11 00								
CP(T)-			0.560	31.000	11.200	4.450	8.900	0.800	0.800
73/01/30	16 00								
73/02/28	10 00								
CP(T)-			0.630	34.000	17.000	4.900	8.400	0.800	0.800
73/02/28	16 00								
73/03/29	09 00								
CP(T)-			1.600	38.700	11.200	5.150	10.500	0.800	0.800
73/03/29	14 00								
73/04/30	11 00								
CP(T)-			0.740	18.000	6.000	1.995	2.800	0.800	0.800
73/04/30	14 00								
73/05/30	11 00								
CP(T)-			1.110	29.000	16.700	3.970	6.500	0.800	0.800
73/05/30	15 30								
73/06/29	11 00								
CP(T)-			1.680	25.500	13.200	2.730	4.300	0.800	0.800
73/06/29	15 00								
73/07/30	11 00								
CP(T)-			0.560	25.200	9.800	3.700	6.200	0.800	0.800
73/07/30	16 00								
73/08/29	11 00								
CP(T)-				31.000	16.600	3.160	4.800	0.800	0.800
73/08/29	15 00								
73/09/28	09 00								
CP(T)-			0.630	30.600	21.000	5.300	7.900	0.800	0.800
73/09/28	13 00								
73/10/31	09 00		1.890	26.000	13.000	2.940	4.300	0.800	0.800
73/11/29	11 30								
CP(T)-			1.600	37.000	18.000	3.300	6.700	0.800	0.800
73/11/29	13 30								

STORET RETRIEVAL DATE 74/11/26

2511A2 LS2511A2
42 30 30.0 071 19 00.0
CONCORD RIVER
25 7.5 BILLERICA
O/BILLERICA IMP.
ST HWY 225 BRDG BELOW CONCORD STP
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/09/09	10 45		0.041	0.800	0.063	0.005K	0.021
72/10/14	11 45		0.430	1.000	0.176	0.105	0.189
72/11/11	10 00		0.560	1.380	0.012	0.147	0.240
72/12/09	11 30		0.450	0.670	0.120	0.038	0.082
73/01/13	11 15		0.650	0.870	0.210	0.054	0.095
73/02/10	10 00		0.470	0.800	0.105	0.025	0.045
73/03/10	11 00		0.420	2.800	0.225	0.060	0.115
73/03/24	10 00		0.420	4.300	0.189	0.040	0.065
73/04/24	10 30		0.300	1.690	0.200	0.098	0.155
73/05/12	11 15		0.315	1.700	0.150	0.098	0.150
73/06/09	09 40		0.252	2.500	0.189	0.120	0.195
73/07/14	10 40		0.220	2.200	0.680	0.189	0.260
73/08/11	11 45		0.230	1.100	0.210	0.147	0.270

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 74/11/26

2511A1 LS2511A1
42 28 30.0 071 21 00.0
CONCORD RIVER
25 705 CONCORD
I/BILLERICA IMP.
MONUMENT ST BRDG ABOVE CONCORD STP
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/09/09	12 30		0.243	1.500	0.240	0.060	0.164
72/10/14	12 50		0.420	1.400	0.170	0.107	0.180
72/12/09	13 15		0.450	0.540	0.126	0.032	0.061
73/01/13	13 00		0.640	0.870	0.168	0.042	0.080
73/02/10	11 15		0.440	0.420	0.071	0.032	0.032
73/03/10	11 30		0.410	1.800	0.160	0.052	0.105
73/03/24	11 30		0.420	5.400	0.252	0.044	0.089
73/04/28	11 30		0.320	1.500	0.350	0.092	0.160
73/05/12	10 40		0.290	0.950	0.138	0.092	0.157
73/06/09	10 10		0.280	1.260	0.100	0.110	0.170
73/07/14	10 10		0.220	1.200	0.660	0.180	0.270
73/08/11	11 25		0.360	2.300	0.230	0.170	0.270

STORET RETRIEVAL DATE 74/11/26

251181 LS251181
42 27 30.0 071 22 00.0
SUDBURY RIVER
25 7.5 CONCORD
T/BILLERICA IMP.
ELM ST BRDG W EDGE OF CONCORD
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/09/09	10 45		0.420	0.675	0.086	0.138	0.260
72/10/14	13 15		0.320	0.900	0.140	0.033	0.080
73/01/13	12 00		0.540	0.600	0.044	0.014	0.035
73/02/10	11 00		0.480	0.420	0.105	0.026	0.045
73/03/10	11 05		0.410	1.680	0.294	0.010	0.040
73/03/24	11 00		0.370	3.360	0.096	0.012	0.035
73/04/28	11 00		0.100	1.500	0.087	0.036	0.075
73/05/12	10 30		0.069	2.400	0.075	0.035	0.070
73/06/09	10 30		0.048	5.200	0.215	0.077	0.135
73/07/14	10 00		0.880	1.470	0.100	0.118	0.270
73/08/11	10 10		0.063	4.200	0.280	0.078	0.200

STORET RETRIEVAL DATE 74/11/26

2511A3 LS2511A3
42 35 30.0 071 17 00.0
CONCORD RIVER
25 7.5 BILLERICA
O/BILLERICA IMP.
LOWELL ST-MT PLEASANT ST BRDG AT DAM
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/09/09	11	23	0.540	1.200	0.154	0.160	0.280
72/10/14	10	45	0.410	0.950	0.16A	0.094	0.175
72/12/04	11	15	0.450	0.540	0.120	0.034	0.084
73/01/13	10	30	0.620	1.050	0.19A	0.04A	0.085
73/02/10	09	00	0.450	0.510	0.095	0.024	0.045
73/03/10	10	15	0.420	2.500	0.210	0.052	0.095
73/03/24	09	00	0.340	3.000	0.154	0.039	0.075
73/04/28	10	00	0.260	1.500	0.37A	0.084	0.145
73/05/12	09	45	0.294	1.700	0.126	0.087	0.145
73/07/14	10	55	0.070	3.500	0.37A	0.140	0.260
73/08/11	11	15	0.134	3.380	0.590	0.120	0.200

STORET RETRIEVAL DATE 74/11/27

251150 TF251150 P000500
42 33 30.0 071 17 30.0
BILLERICA CORR INST
25 7.5 BILLERICA
T/BILLERICA IMPOUNDMENT
CONCORD RIVER
11EPALES 2141204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
72/12/19	08	15							
CP(T)- 72/12/19	15	15	5.700	7.400	1.790	3.910		0.078	0.074
73/01/18	08	15							
CP(T)- 73/01/18	15	15	6.800	11.500	4.000	3.600	5.100	0.026	0.068
73/02/21	08	15							
CP(T)- 73/02/21	15	15	2.500	10.000	5.700	4.200	4.800	0.029	0.083
73/03/22	08	15							
CP(T)- 73/03/22	15	15	3.700	9.500	5.100	3.100	3.450	0.022	0.072
73/04/24	08	15							
CP(T)- 73/04/24	15	15	7.100	7.900	2.900	2.800	4.300	0.043	0.091
73/05/30	08	15							
CP(T)- 73/05/30	15	15	6.400	4.200	1.890	3.900	5.900	0.029	0.071
73/06/26	08	15							
CP(T)- 73/06/26	15	15	6.900	3.300	1.100	3.800		0.025	0.069
73/07/24	08	15							
CP(T)- 73/07/24	15	15	5.600	5.400	1.600	4.400	5.700	0.027	0.067
73/08/28	08	15							
CP(T)- 73/08/28	15	15		3.900		3.960	5.700	0.028	0.063
73/09/28	08	15							
CP(T)- 73/09/28	15	15	5.000	5.500	0.470	4.000	5.500	0.032	0.057
73/10/29	08	15							
CP(T)- 73/10/29	15	15	6.300	8.600	1.470	5.000	7.500	0.024	0.057
73/11/14	08	15							
CP(T)- 73/11/14	15	15	3.300	7.400	0.470	5.700	8.500	0.024	0.051

STORET RETRIEVAL DATE 74/11/27

251151 SF251151 P006000
42 28 30.0 071 20 30.0
CONCORD
25 7.5 CONCORD
T/BILLERICA IMPOUNDMENT
CONCORD RIVER
11EPALES 2141204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
73/07/23	10 00								
CP(T)-			4.700	1.600	1.600	2.700	2.700	0.937	0.980
73/07/23	15 00								
73/08/29	10 00								
CP(T)-				2.100		3.060	3.300	0.597	1.080
73/08/29	15 30								
73/10/02	09 30								
CP(T)-			0.050	28.000	15.400	3.900	6.000	1.000	1.000
73/10/02	16 00								
73/11/30	09 00								
CP(T)-			2.300	4.500	2.200	2.400	3.200	0.705	0.640
73/11/30	14 00								
74/01/29	09 00								
CP(T)-			0.040	1.200	0.040K	2.600	8.600	0.800	0.700
74/01/29	15 00								
74/03/13	09 00								
CP(T)-			0.040	4.400	0.050K	0.050K	3.900	0.732	0.841
74/03/13	15 00								

STORET RETRIEVAL DATE 74/11/27

251152 SF251152 P000925
42 27 30.0 071 23 30.0
CONCORD REFORMATORY
25 7.5 MAYNARD
T/BILLERICA IMPOUNDMENT
ASSABETT RIVER
11FEALES 2141204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO3+NO2 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
72/11/24	10	30	[illegible]	8.850	5.200	3.300	3.500		
72/12/26	13	30	[illegible]	13.000	7.400	0.572	2.200		
73/01/29	10	30	[illegible]	24.000	17.000	0.760	3.400		
74/04/17	09	30	[illegible]	22.000	15.000	3.200	7.100		
74/05/14			12.600	27.000	11.500	3.100	5.300		
74/06/05	11	00	[illegible]	28.000	14.500	3.400	7.900		
74/08/15	11	30	3.543	5.500	0.220	0.065	5.800		
74/10/10	10	30	0.120	5.000	2.400	0.510	1.500		